obliteration of the Mississippi embayment; it is therefore probable that these plants represent the rear guard of a retreating section of the southern forest, a movement entirely independent of and prior to the present advance over the uplifted region; finally there is the testimony of early explorers and settlers indicating that there has been a marked encroachment of the foerst upon the prairies in the northwestern portion within a period corresponding to three or four generations of men. These accounts are interesting as indicating how rapidly the forest has been pushing forward; but most impressive of all is the fact that all of the phenomena of advance, retreat and modification which apparently have taken place in comparatively recent times in the Ozark region may still be observed in operation in its various parts or elsewhere along the margins of the great southern forest.

To the trained observer standing upon a vantage point amid the bald knobs of the Ozarks, noting the manner in which the advance guard of the forest forges its way up the slopes, taking advantage of every ledge and inequality of surface and often succeeding in gaining a foothold upon the level tops when unable to do so on the eroded slopes, there can be no doubt that he is here witnessing the actual encroachment of forest upon prairie lands. Indeed, by the exercise of a little imagination he may almost convince himself that the slow advance of the skirmish line can be seen pushing its way slowly but irresistibly up the steep sides of the prairie strongholds; and if he is of a philosophic turn of mind he may be impelled, by the tragedy he is witnessing in the impending destruction of these last remnants of an ancient flora, to reflect upon the mutability of life and the tragic pageant through which it has passed, involving all things from plant associations to the races of men, since its first appearance upon this planet.

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## NOTES FROM AUSTRALASIA. II

### THE NEW ZEALAND FORESTS

E. H. WILSON

New Zealand, before its settlement by white men, was for the most part densely clothed with mixed rain forest in which old types of Taxads and Conifers were the dominant trees but axe and fire have in less than a century played sad havoc and today much of the land is a jungle of Bracken Fern (*Pteridium aquilinum* Kuhn), Manuka (*Leptospermum scoparium* Forst. and L. *ericoides* A. Rich.), and the naturalized Gorse (*Ulex europeus* L.) and Bramble (*Rubus fruticosus* L.). Originally all the wetter parts where tree-growth was possible in New Zealand were covered with pure forests of Taxads and Conifers but, save on the west coast of the South Island and excepting the Kauri in the north, these old types have long since been unable to compete successfully against the intrusion of the

more modern broadleaf trees. Even without the destructive intervention of the white man it is evident that, in another 500 years perhaps, broadleaf trees will have completely dominated the forests and the Taxads and Conifers will virtually have become extinct over the greater part of New Zealand. Today for the most part the Taxads and Conifers except the Kauri, are scattered thinly through the forests and are crowded on every side by dicotyledonous trees. The undergrowth, except in pure Nothofagus forests, is very dense almost impenetrable and consists of broadleaf shrubs and small trees and Ferns. Climbers, though few in species, are numerically rich and epiphytes, like Astelia, crowd the tree-tops. The higher Cryptogams, especially Ferns, are extraordinarily abundant. Stately Tree Ferns drape the tree-trunks and branches and wet rocks. Club-mosses are plentiful and in the densest shade of the dripping forest the exquisite *Todea superba* Col. abounds. There are no deciduous trees in the New Zealand forest and only a small number have conspicuous flowers. The forests of the North Island are obviously older than those of the South, where the glaciers are even now slowly retreating, and a majority of the trees are distributed through the whole of the country from north to south including Stewart Island. In swampy rather open places the Cabbage Tree (*Cordyline australis* Hook. f.) and the New Zealand Flax (*Phormium tenax* Forst.) are common. The margins of ponds and shallow lakes are crowded with a species of Typha. The flat areas of the thermal region beyond Rotorua are clothed with Manuka (*Leptospermum scoparium* and *L. ericoides*), Bracken Fern and a narrow-leaved, unhealthy looking species of Dracophyllum. The treeless Canterbury Plains now arable land or pastures for sheep and cattle were formerly covered with Tussack grasses as are much of the adjacent mountain ranges and the arid plateau of south Otago. In the alpine areas grow all sorts of curious plants including many herbs with lovely flowers.

The Rimu (*Dacrydium cupressinum* Soland.), Totara (*Podocarpus totara* G. Benn.), White Pine (*P. dacrydioides* A. Rich.), Matai (*P. spicatus* R. Br.) and Miro (*P. ferruginea* Don) and the Kauri (*Agathis australis* Steud.) are the most valuable timber trees in New Zealand. The Kauri, the monarch of New Zealand forest and one of the noblest of existing trees, once formed magnificent forests from a little south of the present city of Auckland northward. Ruthless felling and burning have virtually destroyed the Kauri in so far as commercial lumbering is concerned. There remains only an indifferent State forest at Waipoua where the Kauri is the chief tree, and a national Park (which I visited) of some 700 acres in parts pure stands of Kauri. This valuable conifer is a strikingly handsome tree and its wood is easily worked and exceedingly durable. In young trees the branches are numerous, short and slender and form a narrow pyramidal crown. By means of a layer of special tissue these weak branches are shed after the manner of leaves on deciduous trees and leave a clean trunk quite free of knots. The adult tree is very different in appearance; the crown being open, flattened and fairly wide-spreading.

The trunk is clean, cylindric with no taper and from 50 to 75 or more feet long and is clothed with gray bark which peels off in flakes of no particular shape and form a large mound round the base of the tree. Owing to the smooth, scaling bark no climbing plant hides the beauty of the trunks which stand out above the forest undergrowth like marble pillars in a vast cathedral. The undergrowth is fairly dense but not tall and the Kauri trees tower far above the lovely Tree Ferns and associate plants. The largest tree I saw was about 37 feet in girth and the tallest 150 feet high. The average trees are from 100 to 120 feet tall and from 15 to 20 feet in girth with clean trunks from 60 to 75 feet long. The largest recorded tree had a trunk-girth of 66 feet and there are stories of even larger trees. Owing to the perfectly cylindrical character of the trunk the Kauri yields for its size a greater quantity of timber than any other tree. Millions—young and old—of this magnificent tree have been wantonly destroyed by fire and the fairest of forest scenes laid desolate. The well known Kauri Gum exudes freely from wounds and collects in the axils of the branches. It is also found underground where ancient forests of the tree grew.

The Totara, Rimu, White Pine, Matai and Miro are widely distributed through the length and breadth of New Zealand. The Totara is being rapidly cut out in all accessible places and the Matai and Miro do not seem to be really common trees anywhere but the Rimu and White Pine are still plentiful and on the west coast of the South Island form extensive and fairly pure forest. When young the Rimu is a beautiful tree with long, pendent, light green branchlets but when old is merely a tall pole supporting a small mop-like crown. In fact the same is true of all the chief soft-wood trees of New Zealand when they grow old except the Kauri. A young Totara resembles the common Yew except that its foliage is a lighter green, and young White Pine is very like the Red Cedar (*Juniperus virginiana* L.). The White Pine is best on alluvial river flats where it averages from 120 to 140 feet and has a mast-like trunk buttressed at the base. Its pure white wood is valued for making butter boxes and for this purpose is exported in quantity to Australia. The wood of Rimu, Matai and Miro are used in general carpentry and furniture-making. That of Totara lasts well in the ground and is valued for telegraph poles and the like. So too is that of the Silver Pine (*Dacrydium Colensoi* Hook.), a much rarer tree apparently confined to the west coast. The two species of Libocedrus are useful timber trees and so, too, are the Phyllocladus. *Libocedrus Doniana* Endl. is not found much south of the city of Auckland but *L. Bidwillii* Hook. f. is widespread from the southern part of the North Island southward.

The broadleaf trees are not considered of much commercial value, though the wood of many is durable and will ultimately be in request. Two of the most aggressive of these trees on the North Island are *Beilschmiedia tarairi* Kirk (Taraire) and *Knightia excelsa* R. Br. Very in-

teresting are the various Ratas (Metrosideros spp.) which in the thick forests often commence life as epiphytes on the Taxads, Conifers and other trees. For a time they behave as ordinary root climbers but when their roots reach the ground their strangle-hold on the supporting tree intensifies and the Rata grows round completely enclosing and killing its former host. Often these same species of Rata grow and behave as normal trees do from their youth onward. The wood is heavy, hard and tough and is used for cross-arms on telegraph and telephone poles. But next to the Gymnosperms the most interesting trees are the species of Nothofagus which in many parts of the South Island and the more southerly parts of the North Island form dense, pure forests of considerable extent. Especially is this the case in the drier parts in stony gullies and on the tops of moderately high mountains; in some places they even descend to sea-level. The bark is more like that of the Common Hornbeam than that of our northern Beech. The Nothofagus regenerate readily and singularly resembles our Hemlock (*Tsuga canadensis* Carr.) in general appearance. I saw only small or moderately large trees but was told of specimens 100 feet tall and 25 feet in girth of trunk. They grow thickly together and in pure forests allow no undergrowth. Quite often patches of Nothofagus occur in the ordinary mixed forests but whether under these conditions they are intrusive or vestigial it is difficult to determine.

The forests of New Zealand are not only full of interest but highly instructive phylogenetically since their cycle is clearly manifest. The types are old, very old, even many of the broad-leafs, and the country itself is but a minute remnant of a vast continent which once linked together South America on the one hand and Tasmania and eastern Australia on the other. First in the dim and distant past above the Mosses, Ferns and other Cryptogams rose the Taxads and the Kauri soon to be followed by other Conifers. Possibly the very species existing today but in so far as the sequence of forest types is concerned it does not matter whether it were they or their ancestral types. For a period these trees, unchallenged, forested all the suitable land. Later came the broadleaf dicotyledonous trees, the struggle for supremacy began and today the broadleaf usurpers hold the field. There are no Cycads in New Zealand and the arborescent Monocotyledons are limited to a few small trees which include two Cordylines (*Cordyline australis* Hook. f. and *C. indivisa* Kunth) and a Palm (*Rhopalostylis sapida* H. Wendl. & Drude) known as the Nikau. To these may be added the scandent *Freycinetia Banksii* A. Cunn. which scales to the tops of the highest trees.

In the dense forest shade the New Zealand Taxads and Conifers cannot grow. The seeds often germinate but the seedling plants die after a short struggle. The broad-leaf trees on the other hand regenerate readily in the forests. Where the Taxads and Conifers flourish the soil is humus and peat from 3 to 6 feet deep and it is seldom that the roots descend into the mineralised subsoil. When planted in ordinary soil they grow

very slowly. The broadleaf trees grow under a variety of shade and soil conditions and their roots ramify in all directions. I pulled up seedlings and small plants (I have them dried) of every Taxad and Conifer I came across and in every case found the roots clothed with tubercles. I did the same with the broadleaf trees but found no tubercles present. My attention was directed to the presence of tubercles on the roots of Taxads and Conifers by Captain L. MacIntosh Ellis, the Director of the Forests. Later I found that their presence was known to others but the significance does not appear to have been grasped by anyone but by the Director of Forests and no investigations of this phenomenon have been attempted. The tubercles are analogous with those on the roots of Leguminous plants and in all probability the bacteria break up the raw humic acids and convert them into readily available salts. It is a simple and beautiful case of symbiosis but I have no knowledge of such in our northern Taxads and Conifers though it is known in the case of the Alders and a few other broadleaf trees other than Leguminoseae with which it is general. This discovery is important for, if I am right in my conclusions, the organisms within the tubercles are controlling factors in the rate of growth of the Taxads and Conifers of New Zealand. As evidence let us consider what happens in the forests. The lumberman fells and removes the merchantable trees thus opening up the forest floor to the full influence of the sun and wind. The peaty soil quickly dries, fires come up and destroy not only the remaining growing vegetation but also the peat and the organisms in it thereby rendering the very soil virtually useless for the regrowth of the Taxads and Conifers. When plants of these trees are placed in ordinary garden soil there is no humic acid present even if there be tubercles on the roots of the plants when brought from the forest and consequently they merely linger and their growth is very slow without the acid of the symbiotic organisms. This, I believe, is briefly the whole story of the poor regeneration and slow growth of the Taxads and Conifers in the cut over forests of New Zealand.

HOBART, TASMANIA, *March, 1921.*

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## BIBLIOGRAPHICAL NOTES

ETHELYN M. TUCKER

**Hempel und Wilhelm. Bäume und sträucher des waldes.** The inclusive dates of the three abtheilungen of "Die bäume und sträucher des waldes in botanischer und forstwirthschaftlicher beziehung, von Gustav Hempel und Karl Wilhelm" are readily found to be 1889 to 1899. The dates of publication of the twenty lieferungen forming these abtheilungen are, however, not obtained so easily and are worthy of notice. From *Botanische zeitung* and *Oesterreichische botanische zeitschrift*, with occasional reference to *Flora* for these years, the dates and pages included